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ORIGINAL ARTICLE

Variability in distribution of major and trace elements in Lower Eocene siliceous sections of the Transuralian Region, Russia

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Abstract This paper presents lithologic and geochemical data from the sequence of the Eocene Irbit formation siliceous rocks (Transuralian Region) outcropping in a quarry in the Irbit deposit (thickness of 15 m) and in a large natural outcrop, Belaya Gorka (thickness of 13 m). The data show that both outcrops are composed of diatomites and clayey diatomites, both characterized by a certain degree of lithologic heterogeneity around their chemical, granulometric, and mineralogical compositions; microstructural features; and degree of diatom preservation. The values of indices important for the classification of siliceous rocks and determination of prospects for their industrial application—SiO_2, Al_2O_3, Fe_2O_3, and clay fraction content—ranged from 66% to 77%, 7% to 14%, 3.00% to 5.60%, and 23% to 50%, respectively. In all studied lithologic varieties, element abundances of V, Cr, Mn, Co, Ni, Cu, Zn, Ga, Ge, and Sb were two to three times higher than their respective abundances in the Earth's crust. This is probably related to these elements' involvement in the biological cycle and favorable conditions for transport. Rb, Cs, Ba, and Sr, as well as rare earth elements, are considered the most reliable indicators of lithologic and geochemical subdivision of a sequence of siliceous rocks, as they are associated mainly with clayey minerals. Variations in these indicators have recorded, with great probability, even short-term cycles and semi-cycles of silica sedimentation in the Transuralian Region, as well as tectonic regime and involvement of terrigenous influx.

Keywords Diatomite · Clayey diatomite · Irbit formation · Eocene · Geochemical variability

1 Introduction

Diatomite and its clayey varieties, deposited in a sea basin during the late Paleocene and early Eocene, are one of the most widespread sedimentary rocks and occupy a vast portion of the Transuralian Region. In general, the siliceous deposits are considered from two basic points of view: as a valuable local resource for the production of building materials (Distanov 1976) and as a source of paleogeographic data for reconstructing conditions at the margin of Western Siberia at the Paleocene-Eocene boundary (Smirnov and Konstantinov 2017; Smirnov et al. 2017). The analysis of siliceous fossils plays a conventionally important role in studying siliceous deposits (Gurel and Yildiz 2007; Aleksandrova et al. 2012; Elmas and Bentli 2013). Micropaleontological studies make it possible to reconstruct hydrodynamic, temperature, and hydrochemical conditions of the paleo–sea basin during the lifetime of silica-skeletoned organisms and the accumulation of their corresponding sediments, as well as the dynamics of these organisms' development (Glezer 1974; Smol and Stoermer 2010). Modern ideas about geochronology of specific stratigraphic units, paleogeographic reconstructions, and transgression-regression eustatic cycles are based on a detailed study of siliceous and other microfossils (Rubina 1973; Akhmetiev et al. 2004; Akhmetiev and Beniamovsky 2006; Oreshkina et al. 2008). However, data on the variability in the chemical composition of diatomites of the

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